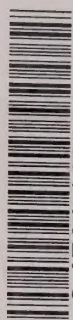


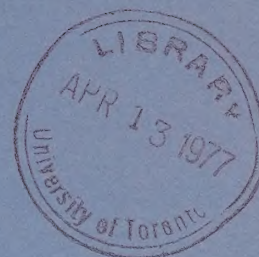
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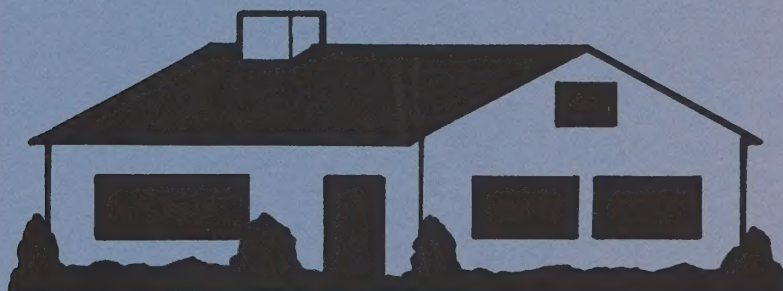
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C.A.M.A. RESIDENTIAL AIR CONDITIONING




Ontario

Ministry of
Colleges and
Universities

Program
Resources
Branch

**C.A.M.A.
RESIDENTIAL
AIR
CONDITIONING**





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C. A. M. A.

RESIDENTIAL AIR CONDITIONING

MAJOR APPLIANCE

SERVICE TECHNICIAN

FOREWORD

This Training Specification is issued by the Program Resources Branch, Ontario Ministry of Colleges and Universities.

The Training Consultant group under Mr. G.I. Bruce, initiated a study by selecting representatives of industry to assist in the preparation of a curriculum. This sub-committee was composed of the following representatives:

Mr. C. Cole	Westinghouse Ltd., Toronto
Mr. H. Hardy	G.S.W. Home Service, Toronto
Mr. A. Kleeger	Electrohome Ltd., Kitchener
Mr. P. Mavety	Canadian General Electric, Toronto
Mr. L. Zarins	Simpson Sears, Toronto
Mr. E. Davis	Program Resources Branch, Ministry of Colleges and Universities, (Chairman), Toronto.

Examinations, for the purpose of supporting this program were developed by Mr. A. C. Brierley and Mr. H. Kotiesen, Examinations Development Coordinators of the Program Resources Branch. The writing of examinations is arranged, by demand, through the Industrial Training Branch.

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SPECIFIC PERFORMANCE OBJECTIVES AND CRITERIA FOR: RESIDENTIAL AIR CONDITIONING			CCDO No.
TERMINAL PERFORMANCE OBJECTIVES : To be able to...	ENABLING OBJECTIVES : Will be able to...	TERMINAL PERFORMANCE CRITERIA : Minimum acceptable standard...	
<ul style="list-style-type: none"> - LOCATE - AIR CONDITIONING SYSTEMS of the following types: <ul style="list-style-type: none"> - Window units - Wall units - Single phase packaged and split systems 	<ul style="list-style-type: none"> - Read prints and schematics - Determine and select a suitable location based upon the: <ul style="list-style-type: none"> - environmental conditions - design and layout of a residence or a room - performance characteristics of the equipment - accessibility to repair and operate the system - adaptability of components - cost of installation - requirements for safe location of the system - Identify possible annoyances such as: <ul style="list-style-type: none"> - hot air discharge from the condenser - noise - disposal of condensate 	<p>Residential air conditioning systems should be located in a clean and ventilated area. Components must be protected from sources of damage.</p> <p>The location of the system will ensure:</p> <ul style="list-style-type: none"> - adequate cooling of the condenser - adequate air circulation through the evaporator - a facility for solid mounting - ease of installation and service - conformance to installation codes and manufacturer's recommendations - safety for people and systems 	

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IDENTIFY: - REFRIGERANTS of the following types: - R12 - R22 - R500	<ul style="list-style-type: none">- Read tables, charts, and drawings- Select and operate the necessary test and measuring instruments- Read identification label on appliance- Determine material properties of the following types:<ul style="list-style-type: none">- flammability- ability to mix with oil- moisture reaction- odor- toxicity- leakage tendency- leakage detection- Determine thermodynamic properties of the following types:<ul style="list-style-type: none">- pressure- temperature- volume- density- enthalpy- Apply safety measures<ul style="list-style-type: none">- by wearing protective clothing- by ensuring sufficient ventilation- by using protective equipment- by following all required safety rules and good housekeeping policies.	The refrigerant must be correctly identified as to type based upon: <ul style="list-style-type: none">- tables and charts- material properties- thermodynamic properties or by reading the identification label if available and affixed on the air conditioning unit.		
HALOCARBONS				

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<p>READ:</p> <ul style="list-style-type: none"> - prints - schematics - diagrams - charts - graphs - tables 	<ul style="list-style-type: none"> - Identify and interpret: <ul style="list-style-type: none"> - the title block - multi-view and pictorial projections - section and auxiliary views - aligned, revolved, and auxiliary sections - dimensions, fits, tolerances, and abbreviations - architectural, piping, welding and electrical symbols - job specifications and addendums - Interpret numerical values and their associated units based upon: <ul style="list-style-type: none"> - the British system - the Metric system - Alternate between: <ul style="list-style-type: none"> - the fractional and numerical notations - the British and Metric systems - Determine the allowance for geometrical, dimensional, and electrical tolerances - Identify and interpret the following data on psychrometric charts: <ul style="list-style-type: none"> - dry-bulb temperature - wet-bulb temperature - relative humidity - pressure - dewpoint - grains of moisture 	<p>Read prints, schematics, and diagrams</p> <ul style="list-style-type: none"> - to determine the mounting area and mounting methods - to enable the installation of: <ul style="list-style-type: none"> - split systems - packaged systems - room and console air conditioners - to determine wiring layout - to determine piping layout of the following lines: <ul style="list-style-type: none"> - refrigerant - water - drain - to enable the calculation of air conditioning loads - to enable troubleshooting and repair of the unit or system <p>Read graphs, charts, and tables</p> <ul style="list-style-type: none"> - to determine air properties - to enable the calculation of air conditioning loads - to enable the selection of tools and hardware 	

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	<ul style="list-style-type: none">- Identify and interpret the following data on service charts:<ul style="list-style-type: none">- symptoms- causes- corrections- references- Read manufacturer's instructions and specifications- Identify and interpret data for:<ul style="list-style-type: none">- specific heat- temperature, pressure, and humidity- Identify and interpret data for the selection of:<ul style="list-style-type: none">- tools- hardware- wiring and piping- replacement parts		

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<ul style="list-style-type: none"> - BRAZE AND SOLDER 	<ul style="list-style-type: none"> - Operate gas welding equipment of the following types: <ul style="list-style-type: none"> - oxyacetylene - propane - Read charts and tables - Select proper torches and tips for: <ul style="list-style-type: none"> - brazing - silver soldering - for various types, shapes, and sizes of material - Apply techniques to braze and solder joints - Select proper filler metals and apply to the correct areas of the work pieces - Determine the correct adjustment for: <ul style="list-style-type: none"> - amount of heat - flame size - type of flame - Apply flux at correct speed and location - Utilize inert gases to prevent oxidation - Select and operate the necessary tools for: <ul style="list-style-type: none"> - securing the workpiece - preparing the workpiece - Position the flame for a clean, efficient, and secure joining of the workpiece - Apply techniques for flat and horizontal position brazing and soldering 	<p>The workpiece must have a clear appearance and be free of porosity or granular joints. Joints must be uniformly penetrated with a minimum amount of filler metal.</p> <p>The workpiece must surpass visual and/or nondestructive testing specifications.</p> <p>All operations will be accomplished safely.</p>	

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<p>TROUBLESHOOT SYSTEM MALFUNCTIONS</p> <ul style="list-style-type: none"> - Apply systematic diagnostic techniques to malfunctions in systems - Recognize satisfactory and below standard operation of air conditioning systems such as: <ul style="list-style-type: none"> - air heating and cooling - halocarbons - the principles of absorption - reverse cycle - water heating and cooling, (hydronic) - Troubleshoot system malfunctions by applying knowledge about the design fundamentals of: <ul style="list-style-type: none"> - air cleaning and filtering units - refrigerant piping systems - air handling and distribution systems - water distribution systems - Select and measure the required conditioning temperature and pressure check points - Understand the operation of typical control systems and the function of control devices, (manual and automatic) such as: <ul style="list-style-type: none"> - electric, - distribution controls, (zone dampers) - refrigerant controls - motor controls - temperature controls - limit controls - overload and safety controls - fan relay controls - fuses 	<ul style="list-style-type: none"> - air heating and cooling - halocarbons - the principles of absorption - reverse cycle - water heating and cooling, (hydronic) - Troubleshoot system malfunctions by applying knowledge about the design fundamentals of: <ul style="list-style-type: none"> - air cleaning and filtering units - refrigerant piping systems - air handling and distribution systems - water distribution systems - Select and measure the required conditioning temperature and pressure check points - Understand the operation of typical control systems and the function of control devices, (manual and automatic) such as: <ul style="list-style-type: none"> - electric, - distribution controls, (zone dampers) - refrigerant controls - motor controls - temperature controls - limit controls - overload and safety controls - fan relay controls - fuses 	<p>System malfunctions will be diagnosed as to source and affected equipment assemblies. Typical air conditioning system malfunctions will include:</p> <ul style="list-style-type: none"> - low capacity at compressor - excessive heat load - air and moisture in the system - undercharged systems - inefficient condenser - overcharged systems <p>Recommendations will be made for repair or replacement of an assembly. Troubleshooting will be done safely and without additional damage to the system. Associated heating system malfunctions may be identified without recommendations for repair or parts replacement.</p>	

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	<ul style="list-style-type: none">- Select and operate leak detectors- Select and operate the required measuring and checking instruments- Measure and check all system parameters- Calculate heat load- Read prints, schematics, graphs, charts, and tables		

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CALCULATE: - HEAT GAIN	<ul style="list-style-type: none"> - Read prints, schematics, and drawings - Calculate surface area of: <ul style="list-style-type: none"> - windows - ceilings - floors - walls - doors - for each and record directional exposure - Determine infiltrated air by <ul style="list-style-type: none"> - people - animals - Calculate miscellaneous sources due to: <ul style="list-style-type: none"> - electrical devices (lights, appliances) - gas burning devices - Calculate the sun effect on each of the surfaces due to exposure - Read tables and charts - Determine factors of heat gain for the above mentioned surface areas - Calculate heat gain for all surface areas - Calculate total heat gain due to all sources - Complete manufacturers estimate form for the purpose of calculating HEAT GAIN 	<ul style="list-style-type: none"> - Determine the heat gain due to: <ul style="list-style-type: none"> - design conditions and room insulation - service - products - and calculate the above to find the total heat gain. 	

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<ul style="list-style-type: none"> - EVACUATE REFRIGERANT: - AIR CONDITIONING SYSTEMS 	<ul style="list-style-type: none"> - Determine if a system has been over-charged - Remove refrigerant safely from a system by venting to the atmosphere, (outdoors if possible), as a vapor - Apply the required methods during evacuation in order to: <ul style="list-style-type: none"> - prevent a freeze up when removing refrigerant - prevent the refrigerant boiling-off at its saturated temperature - avoid spraying oil over the area adjoining the escaping refrigerant 	All evacuations of refrigerant will be accomplished by an economical and safe method.	

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<ul style="list-style-type: none"> - PURGE - AIR CONDITIONING SYSTEMS 	<ul style="list-style-type: none"> - Determine the areas to be purged: <ul style="list-style-type: none"> - liquid line - suction line - evaporation coil, (if non-fast couple) - Operate the correct tools and equipment to: <ul style="list-style-type: none"> - connect and disconnect the lines - cap the lines - open and close the service valves - Operate leak detectors - Apply the most suitable method to purge systems, by: <ul style="list-style-type: none"> - utilizing the service valves on the condenser - operating a purge pump - Operate pressure gauges - Charge the system 	<p>All purging operations will:</p> <ul style="list-style-type: none"> - ensure no leakage - eliminate the non-condensables from the system - avoid contamination of the components of the unit, or system, by employing the material recommended by the manufacturer for the purpose of purging, (example R-11) - be done safely, with special attention to chemical changes which may occur when refrigerants are exposed to an open flame, e.g., gas range 	

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CHARGE - AIR CONDITIONING SYSTEMS	<ul style="list-style-type: none"> - determine and apply, for each system, the correct method for liquid or vapor charging utilizing an efficient and safe procedure - employ the correct charging apparatus and type of refrigerant in order to: <ul style="list-style-type: none"> - ensure that the Service Cylinder is filled to a safe level with the refrigerant required by the system - determine the weight of the refrigerant required by the proper use of weigh scales - make a record of the weight charged into the system - ensure that the system pumpdown capacity is not exceeded - charge factory assembled packaged units using welded compressors - accomplish vapor charging by means of a gauge-manifold into the compressor suction service-valve-port - install a piercing-valve, or fitting, in the suction line if vapor charging is to be implemented - determine and charge the required amount of refrigerant by the following methods: <ul style="list-style-type: none"> - weighing the charge - using a Sight Glass - using a Liquid Level Indicator - checking liquid subcooling - charging by superheat - charging by manufacturer's charging charts 	All specified operations must ensure that the air conditioning-system is not under-charged or over-charged, and all operations will obviate the danger of damage to the compressor valves.	

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<p>SELECT AND OPERATE</p> <ul style="list-style-type: none"> - POWER TOOLS <p>of the following types:</p> <ul style="list-style-type: none"> - Drills - Hammers - Saws - Soldering Guns 	<ul style="list-style-type: none"> - Read charts and tables - Identify the specified power tools based upon: <ul style="list-style-type: none"> - types and sizes - application - operating range - Determine the methods of assembling and adjusting the power tools and their accessories - Read charts and tables - Identify the number and symbol classification - Store and maintain tools - Determine the types and sizes of fasteners or work materials on which the tools will be applied - Determine the methods of applying the hand tools for: <ul style="list-style-type: none"> - safe operation - restricted operations - the most efficient use of the tools - Determine the correct power connections based upon: <ul style="list-style-type: none"> - voltage - current - male/female plugs and receptacles 	<p>Power tools must be correctly selected as to their:</p> <ul style="list-style-type: none"> - type - size and shape - capacity <p>For:</p> <ul style="list-style-type: none"> - the type of operation to be performed - the type of material to be used - the dimensional restriction in which to operate - the force to be applied - the operating rate - the most efficient usage <p>All operations involving the operation of power tools will be performed efficiently and safely, complying with the applicable codes and regulations.</p>	

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<ul style="list-style-type: none"> - SELECT AND USE - HAND TOOLS of the following types: - screwdrivers - wrenches - Allen keys - scrapers and chisels - metal and wood saws - files and reamers - pliers - pipe cutting, flaring and bending tools - hammers - cutters and shears - drifts and punches - taps and dies - clamps and vises 	<ul style="list-style-type: none"> - Identify the types of hand tools specified in terms of their: <ul style="list-style-type: none"> - size and shape - applications to specific materials - strength capacity - operating range - Determine the methods of assembling and adjusting the necessary hand tools - Read charts and tables - Identify the number and symbol classification - Store and maintain tools - Determine the type of fasteners or work materials on which the tools will be applied - Determine the methods of applying the hand tools for: <ul style="list-style-type: none"> - safe operation - restricted operations - the most efficient use to perform the following operations: <ul style="list-style-type: none"> - threading - holding - fastening - cutting - material removal 	<p>Hand tools must be correctly selected as to:</p> <ul style="list-style-type: none"> - type - size and shape - capacity <p>For:</p> <ul style="list-style-type: none"> - the type of operation to be performed - the type of material to be used - the dimensional restrictions in which to operate - the necessary force to be applied - the operating rate - the most efficient usage <p>All operations involving the application of hand tools will be performed efficiently and safely.</p>	

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<ul style="list-style-type: none"> - SELECT AND OPERATE: - ELECTRICAL MEASURING INSTRUMENTS <p>of the following types:</p> <ul style="list-style-type: none"> - voltmeters - ammeters - ohmmeters - wattmeters - ground detectors - meggers 	<ul style="list-style-type: none"> - Read and understand the applications of Ohm's Law - Read prints, diagrams, schematics, charts, and symbols - Identify the various types and applications of electrical measuring instruments - Select the accessories required for their proper operation - Select the correct measuring instrument based upon: <ul style="list-style-type: none"> - its respective application to: - check continuity - check single phase circuits - check and measure voltage (AC-DC), amperage (AC-DC), resistance - check capacitors - the instrument's limitations vis-à-vis <ul style="list-style-type: none"> - measuring range - scale values - sensitivity - resolution and precision - Adjust measuring instrument - Select correct range and scale - Connect the instrument: <ul style="list-style-type: none"> - across the electrical circuit or component - in series with the circuit - by induction 	<p>Select and operate an electrical measuring instrument based upon:</p> <ul style="list-style-type: none"> - its respective application - its limitations <p>To check and measure AC - DC circuits and components.</p> <p>Range selection must be set prior to connections; connections must ensure optimum electrical contact.</p> <p>All operations will be performed safely.</p> <p>Readings will have correct values and units of measurements to a specified accuracy.</p>	

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	<ul style="list-style-type: none">- Interpret meter readings accurately.- Handle and maintain the electrical measuring instruments with care		

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<ul style="list-style-type: none"> - SELECT - REFRIGERANTS of the following types: - R12 - R22 - R500 - R502 <p>HALOCARBONS</p>	<ul style="list-style-type: none"> - Determine the following characteristics of the air conditioning system: <ul style="list-style-type: none"> - type of compressor - tonnage of the compressor - cooling method of the condenser - required evaporator operating temperature - Identify the correct type of refrigerant required for a specific air conditioning system - Select proper containers for the: <ul style="list-style-type: none"> - amount of refrigerant required - type of refrigerant - prevention of contamination to the refrigerant - Determine the methods of safe handling for the refrigerant 	<p>Refrigerants must be selected for their:</p> <ul style="list-style-type: none"> - pressure and temperature relationship for liquification in the condenser - pressure required in the evaporator in order to achieve the evaporation temperature - cooling capacity - ratio of gas volume to the weight of the liquid - flammability and toxicity characteristics - ability to be easily detected for leakage in the type of system in which it is to be employed - ability to resist corrosive action on metals - optimum suitability, as prescribed by the manufacturer, for application to a specific residential air conditioning system 	

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<p>SELECT:</p> <ul style="list-style-type: none"> - DRILL BITS <p>for the following materials:</p> <ul style="list-style-type: none"> - wood - metal - masonry - plastic 	<ul style="list-style-type: none"> - Read tables and conversion charts - Determine the bit diameter based upon: <ul style="list-style-type: none"> - the number size - the fractional size - the metric size - Determine the following shapes of bits: <ul style="list-style-type: none"> - flat - twist - auger - Determine the following types of bits: <ul style="list-style-type: none"> - carbon steel - high speed steel - carbides - Determine the following types of shanks: <ul style="list-style-type: none"> - straight - tapered - Determine: <ul style="list-style-type: none"> - the required pressure on the drill - the speed for rough and finished drillings - the need for cutting oil - the correct method to sharpen drill bits taking into consideration the angle of the cutting edge 	<p>Select drill bits:</p> <ul style="list-style-type: none"> - to produce the following types of holes: <ul style="list-style-type: none"> - through - blind - countersunk - multi-diameter - to enlarge, ream or finish a given hole 		

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<ul style="list-style-type: none"> - SELECT - HARDWARE <p>of the following types:</p> <ul style="list-style-type: none"> - nails - screws - nuts and bolts - staples - washers - clips and pins 	<ul style="list-style-type: none"> - Read charts and drawings - Identify the various types and applications of hardware - Select the correct piece of hardware based upon: <ul style="list-style-type: none"> - size - type - length - application - for the following materials: <ul style="list-style-type: none"> - metals - wood - concrete - plastics - of various thicknesses 	<p>Select the correct hardware for an application based upon:</p> <ul style="list-style-type: none"> - size - type - length <p>for various materials</p>	

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<ul style="list-style-type: none"> - SELECT - MECHANICAL MEASURING INSTRUMENTS <p>of the following types:</p> <ul style="list-style-type: none"> - tapes and rules - spirit levels - straight edges, squares and protractors - plumb bobs - chalk lines - callipers and dividers - weight scales 	<ul style="list-style-type: none"> - Read prints and diagrams - Identify the various types and applications of instruments - Select the measuring instrument based upon: <ul style="list-style-type: none"> - its respective application: <ul style="list-style-type: none"> - to measure inside and outside dimensions - to check straightness and levelness - to determine weights - the size and shape of the object or surface - the selected unit of measurement based upon: <ul style="list-style-type: none"> - the British system - the Metric system - the instrument's limitations, specifically <ul style="list-style-type: none"> - the range - the scale values - the resolution - the tolerance 	<p>Select a mechanical measuring instrument based upon:</p> <ul style="list-style-type: none"> - the type and size - the application to: <ul style="list-style-type: none"> - measure - align - test - check - weigh objects and surfaces - the instrument's limitation 	

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<p>CONNECT AND OPERATE</p> <p>- THE GAUGE MANIFOLD</p> <p>NOTE:</p> <p>The gauge manifold includes the following components:</p> <ul style="list-style-type: none"> - hoses - couplings - valves - gauges and gauge openings 	<ul style="list-style-type: none"> - read diagrams, charts and tables - operate the correct tools and equipment for: <ul style="list-style-type: none"> - mounting the manifold securely - connecting hoses, tubing and couplings - cleaning the gauges and the valves - repairing leaks - select the correct size of hoses and couplings and determine the location in the system to connect them - identify the components and determine the fundamentals of operation of each - detect, isolate and repair leakage in the components - determine the correct methods to operate the gauge manifold according to the function to be performed, such as: <ul style="list-style-type: none"> - reading pressures - charging (oil and refrigerant) - purging - testing for leaks - disconnect and remove the gauge manifold such that: <ul style="list-style-type: none"> - no air is admitted to the system - no refrigerant or oil is lost 	<p>The gauge manifold will be connected safely and securely to prevent leakage in the connections.</p> <p>The gauge manifold will be operated safely to perform functions such as:</p> <ul style="list-style-type: none"> - taking pressure readings - checking for leaks in the system - charging and evacuating - adding oil - by-passing the compressor - unloading the gauge lines of high pressure liquid and vapor <p>No leakage is permitted. Air must not be admitted and no refrigerant or oil lost after the manifold is disconnected</p>	

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<ul style="list-style-type: none"> - OPERATE: - TEST INSTRUMENTS of the following types: <ul style="list-style-type: none"> - hydrometers and moisture indicators - salometers - pressure and electronic vacuum gauges - dry and wet bulb thermometers - stroboscope and stop watch - fluid and gaseous flow meters - test lamps - electrical meters - leak detection devices of the following types: <ul style="list-style-type: none"> - halide leak detector - electronic leak detector - soap test - sulphur test - ph indicators - acid test kit 	<ul style="list-style-type: none"> - Read prints, diagrams and charts - Adjust and calibrate the test instrument - Select correct range and scale - Connect and operate the instrument; interpret the results by giving correct value and unit of measurement - handle, maintain, and store the instrument safely 	<p>Operate test instruments to check, measure, and test:</p> <ul style="list-style-type: none"> - electrical circuits - liquid lines - the air conditioning system <p>Instruments will be utilized with care, and maintained and stored according to the manufacturer's specifications.</p>	

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<ul style="list-style-type: none"> - OPERATE: - MECHANICAL MEASURING INSTRUMENTS of the following types: <ul style="list-style-type: none"> - tapes and rules - spirit levels - straight edges, squares and protractors - plumb bobs - chalk lines - callipers and dividers - weight scales 	<ul style="list-style-type: none"> - Read prints and diagrams - Adjust measuring instrument - Measure, align, test, check and weigh objects and surfaces - Interpret reading by giving correct valve and unit of measurement - Handle, maintain and store the instrument 	Operate mechanical measuring instruments to: <ul style="list-style-type: none"> - measure - align - test - check - weigh objects and surfaces	

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<ul style="list-style-type: none"> - TEST AND REPAIR OR REPLACE SYSTEM CONTROLS cf the following types: <ul style="list-style-type: none"> - thermostats - pressure switches - humidistats 	<ul style="list-style-type: none"> - Read schematics and diagrams - Assemble and disassemble all the specified system controls - Operate the controls by adjusting them manually - Identify the components of the controls and determine the fundamentals of operation of each - Select and operate the correct tools for the repair operation - Select and operate the proper measuring instruments to isolate the malfunction - Employ a methodical troubleshooting service analysis - Determine the tolerance range for the control setting - Select the correct replacement components 	<p>The source of the malfunction must be isolated. The system controls will be repaired or replaced safely with minimal disruption to the system. All repair operations on system controls will:</p> <ul style="list-style-type: none"> - ensure proper electrical wiring and connections - maintain the proper: <ul style="list-style-type: none"> - temperature - humidity - pressure - within the specified tolerance range 	

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<ul style="list-style-type: none"> - INSTALL AND REPLACE: <ul style="list-style-type: none"> - PIPING - AIR CONDITIONING <ul style="list-style-type: none"> - copper - brass - aluminum - steel - iron - plastic 	<ul style="list-style-type: none"> - Read charts, drawings, piping diagrams and manufacturer's instructions - Select the required piping for a specific application in order to ensure: <ul style="list-style-type: none"> - the required degree of temperature - correct wall thickness - resistance to corrosion - suitability for pressure or non-pressure applications - Select and operate the required tools in order to: <ul style="list-style-type: none"> - cut piping in such a manner to prevent chips from falling into the section that is to be used - bend piping without causing ruptures or flattening of the pipe - flare piping to form a leakproof joint between pipe and a fitting - effect swaging, threading, and glueing of piping - anneal and constrict piping for use during installation, or when replacing piping in an existing facility - Select, install, or replace insulation and fittings for piping to ensure: <ul style="list-style-type: none"> - the correct fitting for a specific installation - proper soldered connections between the fitting and the piping employed in the air conditioning system 	<p>All piping utilized in an airconditioning system will be suitable to the design of the system. And allow for correct velocities, variations in pressure, and protection for the compressor.</p> <p>Piping must be clean and dry inside, and be kept sealed at the ends in order to facilitate cleanliness during handling.</p> <p>Procedures employed for supports and hangers will meet the requirements of applicable codes and regulations.</p>	

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	<ul style="list-style-type: none"> - Determine and implement the correct procedure to: <ul style="list-style-type: none"> - install pipe hangers and supports - cut and thread rod hangers - install or replace hangers in steel, concrete or wood - based upon the following considerations: <ul style="list-style-type: none"> - required frequency of support in order to keep piping straight and in firm position - eliminations of chafing or galvanic action between hangers (clamps) and piping - Determine and apply the correct methods: <ul style="list-style-type: none"> - to install or replace piping along walls or ceilings - to provide adequate protection for piping which is run through floors or walls - to arrange tubing/piping horizontally and vertically with bends as close to perfect radius as possible - in order to install the suction lines so that piping will drain toward the compressor - to place the covering on the piping prior to assembly - to avoid positioning piping near sources of heat or extreme cold - to seal piping, during installation, immediately following flared or streamlined connections - to arrange the piping in such a manner that the supports will protect the tubing from accidents 	<p>The installation or replacement of piping will include care to prevent damage to the material.</p> <p>In a non-code installation, where individual suction lines and liquid lines run into main lines, T - connections may be uses.</p> <p>Valves, driers, or other heavy objects must not be supported by the piping or tubing.</p> <p>The installation or replacement of piping will be performed safely. The work will be in accordance with manufacturer's specifications.</p>	

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INSTALL: - strainers - screens - filters - activated carbon - adhesive - electrostatic - water filters	<ul style="list-style-type: none"> - Read prints, schematics, sketches and diagrams - Select and operate the required tools to clean and/or install: <ul style="list-style-type: none"> - filter elements located before expansion valves - filters following the liquid receiver - a filter which has been built into the suction of a compressor - filters installed before expansion valves - Determine and apply the correct methods and procedures to prevent dirt, scale and sludge from: <ul style="list-style-type: none"> - plugging small valve orifices - holding valve needles open - scoring parts of compressors 	Filters, strainers and screens will be properly located and meet the requirements for correct function, in order to assure protection from dirt, scale and sludge in a refrigeration system.	

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<ul style="list-style-type: none"> - INSTALL: - RESIDENTIAL (CENTRAL) SYSTEMS Single Phase, Pre-charged, Hermetically Sealed Systems of the following types: - packaged - split systems - combined <p>NOTE: Combination systems have independent heating and cooling operations.</p>	<ul style="list-style-type: none"> - read prints, diagrams and schematics - receive and uncrate a system and check the shipment for shortage or damage - select and operate the required tools - perform the necessary electrical and mechanical checks, tests and measurements including low and high pressure; oil failure switches and thermostats - mount air conditioning systems based upon: <ul style="list-style-type: none"> - space requirements and mounting methods - an adequate supply of air or water - the specified air flow - sufficient ventilation - accessibility - drain facilities - duct layout - piping layout - installation codes - check rotation of electric motors on fans and compressor motors - alter or replace plenum to proper size depending on evaporator coil dimensions - increase motor horse power to next size larger than existing motor, and speed up fan rotation (CFM) to overcome pressure drop across evaporator coil - use variable pitch pulley and check the motor amperes 	<p>All air conditioners will:</p> <ul style="list-style-type: none"> - be levelled and mounted firmly - have proper electrical and mechanical connections - have no leakage in refrigerant or water lines - transfer the required quantity of heat during the cooling cycle or heating cycle - operate with minimal noise and vibrations - be installed according to the installation codes and manufacturer's instructions 	

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	<ul style="list-style-type: none"> - make the pipe connections including couplings and fittings to the following lines: <ul style="list-style-type: none"> - water and drain - refrigerant (suction, liquid) - drain (condensate) - defrost (condensate) - based upon: <ul style="list-style-type: none"> - types and sizes of fittings: <ul style="list-style-type: none"> - flared connections - brazed connections - quick connect and disconnect couplings - the specified refrigerant - the piping layout - the installation codes - layout, install, and connect the following lines: <ul style="list-style-type: none"> - suction - liquid - water - defrost - drain - dehydrate (vacuum) - purge, dehydrate (vacuum), charge and test the system - start the system - apply safety measures: <ul style="list-style-type: none"> - by wearing safety shoes and hats (no rings should be worn) - by using protective equipment - by ensuring sufficient ventilation - to handle and store refrigerants in a cool location 		

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	<ul style="list-style-type: none"> - to use hoisting and lifting equipment, power and manual tools, welding equipment - by following safety rules and good housekeeping policies - to the storage and handling of oils 		

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<ul style="list-style-type: none"> - INSTALL - AIR CLEANER ASSEMBLIES <p>of the following types:</p> <ul style="list-style-type: none"> - electronic - air washers - filters, dry and viscous <p>NOTE: Filters are of the following types:</p> <ul style="list-style-type: none"> - replaceable - manually-cleaned - automatically-cleaned <p>Electronic filters are of the following types:</p> <ul style="list-style-type: none"> - ionizing - charged media <p>The air cleaner assembly includes:</p> <ul style="list-style-type: none"> - filter - recirculating pump - power pack - wiring and controls - washer nozzle and holding tank 	<ul style="list-style-type: none"> - Read prints, diagrams and schematics - Receive and uncrate a specified assembly and check the shipment for shortage or damage - Select and operate the required tools - Perform the necessary electrical and mechanical checks, tests and measurements - Mount air cleaner assemblies based upon: <ul style="list-style-type: none"> - space requirements of mounting methods - the selection of the assembly - specified air flow - adequate water supply - drain facilities - duct layout - piping layout - environmental conditions - installation codes - Connect electric motors, power pack and controls based upon: <ul style="list-style-type: none"> - power, voltage and phase requirements - electrical codes - Make the pipe connections including couplings and fittings to: <ul style="list-style-type: none"> - water or steam lines - drain lines <p>based upon the following considerations:</p> <ul style="list-style-type: none"> - types and sizes of fitting - piping layout - installation codes 	<p>All air cleaner assemblies will:</p> <ul style="list-style-type: none"> - be levelled and mounted firmly - have proper component alignment - have proper electrical and mechanical connections - maintain correct water flow - have correct shaft rotation and speed - handle the specified quantity of air - remove the amount of dust required - be accessible for removal and cleaning - have no air leakage - operate with minimal noise and vibrations - be installed according to installation codes and manufacturer's instructions 	

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INSTALL - AIR CONDITIONERS - window units - wall units	<ul style="list-style-type: none"> - Read and understand pictorial diagrams, drawings, schematics, sketches, and symbols - Select and operate the required tools in order to ensure that: <ul style="list-style-type: none"> - the window unit is installed safely - the unit is securely fastened in position - the unit is sealed to minimize air infiltration - the window is secured in the proper position - Select and operate the required measuring instruments to check: <ul style="list-style-type: none"> - alignment and proper mounting of the equipment - the housing adjustment to ensure approx. $\frac{1}{4}$"/foot tilt downward on the outside of the window in order to provide for condensate drainage if condensation should occur on the exhaust side of these units - Determine and apply the correct methods to: <ul style="list-style-type: none"> - facilitate a leakproof seal, and securely install window and wall units in accordance with the manufacturer's design and recommendations 	<p>Window units will be installed with a slight downward tilt toward the outdoors. A security bracket must be utilized to mount the window unit firmly in position.</p> <p>Electrical connections will comply with the manufacturer's specifications and installation codes. Window and wall units must employ polarized (three prong) plugs.</p> <p>The circuit should be protected by a circuit breaker or a time delay fuse. The wall outlet should be checked to ensure that it is grounded to accommodate the air conditioner's three pronged plug. Do not lift a unit without a helper.</p>	

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<p>INSTALL:</p> <p>Control Devices - Electrical</p> <ul style="list-style-type: none"> - thermostats - contactor relays - indoor fan relay - overload devices - fuses - humidistats - pressure switches 	<ul style="list-style-type: none"> - Check a control device for damage - Read and understand prints, sketches, manufacturer's diagrams and schematics for air conditioning - Select and apply the required tools and techniques in order to ensure: <ul style="list-style-type: none"> - accurate mounting of components - clean and firm electrical connections - adjustment of controls according to the manufacturer's specifications - Select and operate the required measuring instruments to check: <ul style="list-style-type: none"> - electrical parts in a circuit - electrical devices that are not connected to power - a single phase circuit - Determine and apply the correct methods to ensure: <ul style="list-style-type: none"> - that the various control devices are functional and suitable in the system for which they are employed - that optimum performance is enjoyed by the customer - that procedures for safety are employed in the area of work 	<p>Control devices will be installed and adjusted according to the manufacturer's specifications.</p> <p>Instruments will be employed to check circuits to determine if they are electrically charged before handling wires, terminals, or parts. The electrical power will be disconnected before working on the electrical parts of an air conditioning system.</p>	

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<ul style="list-style-type: none"> - REPAIR AIR CONDITIONERS of the following TYPES: <ul style="list-style-type: none"> - window units - wall units 	<ul style="list-style-type: none"> - Read prints, schematics, graphs, charts and tables - Shut-down and start the system - Select and operate: <ul style="list-style-type: none"> - the required tools - the measuring instruments - Troubleshoot the unit by systematic analysis to locate the malfunction - Select the correct replacement components - Repair or replace the following system components: <ul style="list-style-type: none"> - the evaporator assembly - the condenser assembly - the compressor assembly - the metering device - the refrigerant lines - the electrical wiring - the electrical controls - Repair the system by: <ul style="list-style-type: none"> - replacing filters and driers - repairing leaks - evacuating the system - replacing faulty components - lubricating the fan bearings where necessary - eliminating noise - purging the system - Charge the system 	<p>The source of the malfunction must be isolated.</p> <p>All residential air conditioners will:</p> <ul style="list-style-type: none"> - have no refrigerant leaks - be mounted firmly and levelled according to manufacturer's specifications - maintain proper condenser ventilation - have proper mechanical and electrical connections - ensure correct air flow, balance and distribution - maintain the desired temperature and humidity levels, if properly sized - operate with minimal noise and vibrations - be repaired safely according to codes to meet manufacturer's specifications. 	

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	<ul style="list-style-type: none">- Test and adjust the system controls- Apply safety measures:<ul style="list-style-type: none">- by wearing protective clothing- to use brazing equipment, hand and power tools- by following safety rules			

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<ul style="list-style-type: none"> - REPAIR - CONDENSER ASSEMBLIES <p>of the following types:</p> <ul style="list-style-type: none"> - air-cooled <p>NOTE: The above assemblies include the following components:</p> <ul style="list-style-type: none"> - condenser-coil - condenser-receiver - valves - fan - drive motor and controls - pipes and fittings - water regulating valve 	<ul style="list-style-type: none"> - Apply the correct methods to repair the specified types of condenser assemblies, such as: <ul style="list-style-type: none"> - brazing and silver soldering - reinstalling - combing or realigning of fins - repair or replacement of electrical wiring and controls - replacement of component parts - cleaning, draining and flushing of piping and tubing - cleaning of air cooled condenser fins - Identify the components and determine the fundamentals of operation of each component - Select replacement components - Operate the applicable tools, chemical cleaners and measuring instruments - Shut-down and start-up the system - Evacuate and recharge the system - Replace defective condenser fan - Replace defective condenser fan motor - Replace fan belts - Repair or replace water regulating valves 	<p>The source of the malfunction must be identified.</p> <p>The condenser assembly will be repaired or replaced safely with minimal disruption to the system.</p> <p>All the specified repair operations on the condenser assemblies must:</p> <ul style="list-style-type: none"> - have total heat dispersion out of the cooling medium - be within the regulations and codes governing the wiring and controls - have the required fin spacing and alignment - result in minimal noise and vibration - have no leakage or obstruction in the tubing, piping, and fittings - result in maximum air flow - result in optimum water flow - determine the condition of the water regulating valve 	

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<ul style="list-style-type: none"> - REPAIR - EVAPORATOR ASSEMBLIES <p>of the following types:</p> <ul style="list-style-type: none"> - air-cooling <p>NOTE: The above assemblies include the following components:</p> <ul style="list-style-type: none"> - coil - valves and couplings - fan - drive motor and controls 	<ul style="list-style-type: none"> - Read prints, charts, and schematics - Apply the correct methods to repair the specified types of evaporator assemblies, such as: <ul style="list-style-type: none"> - brazing and soldering - refastening - combing or realigning of fins - repair or replacement of electrical wiring or connections - replacement of component parts - defrosting or deicing the coils - cleaning, draining, and flushing of piping and tubing - Identify the components and determine the fundamentals of operation of each - Select replacement components - Operate the applicable tools, fasteners, and measuring instruments - Isolate the malfunction accurately - Shut-down and start-up the system - Evacuate and charge the system 	<p>The source of the malfunction must be identified.</p> <p>The evaporator assembly will be repaired or replaced in a safe and efficient manner.</p> <p>All the specified repair operations on evaporator assemblies will:</p> <ul style="list-style-type: none"> - have the required fin spacing and alignment - maintain the maximum specified heat transfer - be within the regulations and codes governing wiring and controls - have no leakage in the tubing and fittings - remove all ice and build-up on the coil - maintain the correct cycle for the operation and defrost function 	

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<ul style="list-style-type: none"> - REPAIR - HEAT PUMP SYSTEMS <p>of the following types:</p> <ul style="list-style-type: none"> - Air to Air - Water to Air <p>NOTE: Heat pump systems contain the following:</p> <ul style="list-style-type: none"> - compressor assembly - outdoor coil assembly - indoor coil assembly - pipes and tubing - valves and couplings - wiring and controls - indoor fan assembly - electric resistance heaters 	<ul style="list-style-type: none"> - Read prints, charts, tables, graphs and schematics - Start and shut-down the system - Evacuate, purge and charge the system - Assemble and disassemble component parts of the system - Operate the correct tools and equipment for: <ul style="list-style-type: none"> - replacement of assemblies or component parts - replacement of the system - assembly, disassembly, evacuating, purging and charging - the repair of leaks - Operate the correct measuring instruments for: <ul style="list-style-type: none"> - relative humidity - air, water and refrigerant temperature and flow - electrical circuits and controls - detecting leaks - Identify the component assemblies and parts, of and determine the fundamentals of operation of each component - Operate the controls to accomplish: <ul style="list-style-type: none"> - heating - cooling - and defrosting 	<p>The source of the malfunction must be established.</p> <p>The heat pump will be repaired or replaces safely with minimal disruption.</p> <p>All the repair operations on heat pump systems will:</p> <ul style="list-style-type: none"> - ensure the correct cycle for heating, cooling and defrosting - be within the codes and regulations governing the wiring and controls - ensure no leakage of refrigerant - maintain the set temperature in the occupied space - ensure proper air or water circulation through the coils - ensure minimal noise and vibration during operation - ensure that operating pressures and temperature in the refrigeration cycle are in accordance with the manufacturer's specifications - ensure that the refrigerant charge is correct - Identify problems related to electrical supply, or air handling systems, as well as problems in the heat pump unit 	

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<ul style="list-style-type: none"> - REPAIR - METERING DEVICES of the following types: - capillary tube - thermostatic expansion valve 	<ul style="list-style-type: none"> - Read charts and tables - Evacuate and recharge the system - Shut-down and start the system - Operate the tools and equipment for: <ul style="list-style-type: none"> - evacuation and recharging - removing the metering device from the system - adjusting necessary parts - replacing the device in the system - Operate the measuring instruments for: <ul style="list-style-type: none"> - temperature - pressure gauges - Clean, flush, and purge the metering devices - Select the correct replacement device - Lubricate gaskets with prescribed refrigeration oil when repairing TX valves 	<p>The source of the malfunction must be established.</p> <p>The metering devices will be repaired or replaced safely, and with minimal disruption to the system.</p> <p>All repair operations on metering devices will:</p> <ul style="list-style-type: none"> - ensure no leakage - maintain correct pressure in the refrigerant lines and the evaporator - maintain the correct evaporator temperatures 	

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<ul style="list-style-type: none"> - REPAIR: - RESIDENTIAL (CENTRAL) SYSTEMS Single Phase, Pre-charged, Hermetically Sealed Systems of the following types: - packaged - split systems - combined <p>NOTE: Combination systems have independent heating and cooling operations.</p>	<ul style="list-style-type: none"> - read prints, graphs, schematics, charts and tables - shut-down and start the system - operate the necessary tools and equipment to complete the repair - operate the required measuring instruments to isolate the malfunction - repair or replace the following system components: <ul style="list-style-type: none"> - the evaporator assembly - the condenser assembly - the compressor assembly - piping and tubing - control valves and electrical controls - metering devices - identify the system components and determine the fundamentals of operation of each - determine and apply the most suitable procedures to repair the system, such as: <ul style="list-style-type: none"> - replacing filters, driers, gaskets - repairing leaks - purging the system - defrosting - replacing faulty components - lubrication of the necessary areas - troubleshoot the system by employing a methodical service analysis - select the correct replacement components. 	<p>The source of the malfunction must be isolated</p> <p>The air conditioning system will be repaired safely with minimal disruption to the immediate environment</p> <p>All repair operations on the system will:</p> <ul style="list-style-type: none"> - ensure no leakage - maintain proper condenser ventilation - ensure the proper system control operations for: <ul style="list-style-type: none"> - temperature - humidity - defrost - ensure correct air flow and distribution in single and multi-zone units - maintain minimal noise and vibration during operation - be done according to the pertinent codes and regulations 	

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<ul style="list-style-type: none"> - MAINTAIN: <ul style="list-style-type: none"> - AIR CONDITIONING SYSTEMS of the following types: <ul style="list-style-type: none"> - halocarbons - air cooling 	<ul style="list-style-type: none"> - Read prints, schematics, charts, and tables - Identify all the system components, and determine the fundamentals of operation of each component - Apply methods of troubleshooting when a malfunction is present in a system - Formulate and apply methods of overhauling systems for maintenance purposes including: <ul style="list-style-type: none"> - checking and replacing filters - adjusting belts and pulleys - checking system controls and control valves - tightening contacts, relays and electrical controls - replacing oil and driers - testing for leaks in the system - draining, flushing, and cleaning water hoses and tubes - the measurement of gas and liquid pressure and temperature - the lubrication of all the areas necessary to ensure the smooth operation of the system - Charge, purge, and evacuate systems - Operate the tools and measuring instruments necessary for the maintenance of the air conditioning system 	<p>System malfunctions must be recognized. Maintenance tasks will be performed safely with minimal disruption to the system. The complete system must be checked to ensure:</p> <ul style="list-style-type: none"> - clean tubing, hoses, and filters - proper assembly operation - no impurities in the refrigerant and the oil - safe electrical connections and controls - proper operation of system controls - sufficient lubrication of moving parts 	

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<ul style="list-style-type: none"> - EMPLOY AND MAINTAIN - VACUUM PUMP ASSEMBLIES <p>NOTE: The above assemblies include the following components:</p> <ul style="list-style-type: none"> - hoses and couplings - valves - mountings - pump and motor - controls 	<ul style="list-style-type: none"> - Employ the correct type and size of vacuum pump for a specific application - Determine from the manufacturer's specifications the required: <ul style="list-style-type: none"> - type of drive: <ul style="list-style-type: none"> - belt - direct - capacity - voltage and power rating - pressure tolerance rating - horsepower - Utilize the recommended types of mountings and fasteners prescribed by the manufacturer - Identify the correct components and determine the required fundamentals of operation, in order to employ and maintain the assembly to achieve fitness for use - Determine the correct connecting hoses based upon the valves and couplings, and maintain these components in a safe and efficient manner 	<p>Vacuum pumps must be correctly employed as to their:</p> <ul style="list-style-type: none"> - type - size - capacity - voltage and power rating - pressure tolerance rating <p>For:</p> <ul style="list-style-type: none"> - the substance being evacuated: <ul style="list-style-type: none"> - vapour - moisture and air - the amount of material being evacuated and the rate of evacuation - the power supply - the required pressure and tolerance levels <p>Vacuum pumps will be maintained in the manner prescribed by the manufacturer</p>	

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<p>MAINTAIN:</p> <ul style="list-style-type: none"> - AIR CLEANER ASSEMBLIES <p>of the following types:</p> <ul style="list-style-type: none"> - electronic - air washer - filters (dry and viscous) <p>NOTE:</p> <p>The above assemblies include the following components:</p> <ul style="list-style-type: none"> - filter - recirculating pump - wiring and controls - washer nozzels and holding tank 	<ul style="list-style-type: none"> - Read prints, schematics, and charts - Assemble and disassemble the air cleaner - Operate the correct tools and equipment for <ul style="list-style-type: none"> - removal from the system - replacement in the system - disassembly and assembly - Clean filters using the proper equipment - Check for physical damage of the following types: <ul style="list-style-type: none"> - bent plates - poor contacts - dirty insulators - damaged wiring - Check air cleaner assemblies for: <ul style="list-style-type: none"> - corrosion - algae build-up - scale build-up - Recognize satisfactory and below standard checks and correct for them by: <ul style="list-style-type: none"> - straightening - tightening - cleaning - selecting proper additives - Start and operate the assembly 	<p>The air cleaner assembly must be maintained to operate at the manufacturer's specified parameters by:</p> <ul style="list-style-type: none"> - cleaning filters - correcting for physical damages - eliminating corrosion and build-up - ensuring proper electrical function of the assembly <p>All maintenance operations will be performed safely with minimal disruption to the system.</p>	

